

## Nonneurocognitive Extended Consciousness

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One of the attributes necessary for Watson to be considered human is that it must be conscious. From Rachlin's (2012) point of view, that of teleological behaviorism, consciousness refers to the organization of behavioral complexity in which overt behavior is distributed widely over time. Thus, a computer such as Watson could be considered to be conscious if it behaves like a conscious person. This last point is critical because of the implications that it holds for philosophy of mind. For a behaviorist, consciousness is not required to be internal event, nor is it self-evident that the mind resides inside of us. Consciousness is instead something that humans do, or achieve, in their overt and covert actions (Schlinger, 2008). Rachlin believes that if it were possible to generate the same actions using a different mechanism, the behavior would be no less conscious than our current behavior. This is because consciousness is not part of the mechanism responsible for the behavior, it is the behavior itself.

To provide contrast for his views, Rachlin introduces the work of Tononi and Edelman (1998), who suggest that consciousness correlates with the occurrence of reciprocal action between distributed activity in areas of the brain. This work, Rachlin suggests, is potentially beneficial, in that it could one day identify the internal mechanism that underlies human consciousness. This mechanism could one day be shown to be sufficient to generate conscious

behavior. However, Rachlin believes that it is not only unlikely that a specific mechanism would be found, he does not believe that such a mechanism would be necessary for consciousness. Rachlin also contrasts his view with the *enacted mind* or *extended cognition*; citing the work of Noë (2009) in particular, he suggests that the mind is a result of the interaction between the whole organism and its environment. Rachlin claims that, like Tononi and Edelman, Noë and other proponents of enactment or extended cognition retain an essentially neurocognitive view of the mind, merely expanding its scope spatially to encompass the external environment. Because of this neurocognitive view of the mind, Rachlin believes these research programs fail to study consciousness itself, and instead only study the underlying mechanism of consciousness.

We agree with Rachlin that a neurocognitive approach to cognition and consciousness is likely to miss the boat in many ways. We also agree with Rachlin that most proponents of extended cognition are arguing for a neurocognitive approach, according to which portions of the environment are literally components of the computational system that spans brain, body, and environment. Perhaps the most widely discussed example of this neurocognitive extended cognition is seen in Tetris playing, as studied by Kirsh and Maglio (1994). Tetris is essentially a game of brick laying, but with irregularly shaped bricks called *zoids*; the object is to move and rotate the zoids so that they make full rows along the bottom of the playing area. Based on a long history of studying

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“mental rotation” in cognitive psychology (e.g., Shepard & Metzler, 1971), Kirsh and Maglio assume that mentally rotating objects like zoids is a slow and difficult neurocomputational task, and one prone to errors. Kirsh and Maglio found that experienced Tetris players rotate falling zoids onscreen to see if they will fit into slots before putting them into place. In so doing, they transform a slow and difficult neurocomputational task into a fast and easy perceptual task. Because the onscreen rotation plays the same role in the task as the unproblematically cognitive mental rotation would have, we are justified in calling the onscreen rotation a literal part of the cognitive process. Thus, the cognitive system that plays Tetris is not bound to the brain, but also includes the player’s body and the computer they are using. This sort of neurocognitivist extended cognition is often called *wide computationalism*; thinking is an essentially computational phenomenon, but the material that implements the computation often extends beyond the brain and body (Clark, 1997; McClamrock, 1995; Wilson, 2004). As Rachlin points out, the extended part of this sort of wide computationalism is spatial in nature.

Not all versions of extended cognition are of a piece, though. In addition to the neurocognitivist wide computationalism outlined above, there are several nonneurocognitivist versions of extended cognition. Although we do not presume to speak on his behalf, we believe that Noe’s version of enactivism is not neurocognitivist. We can, however, presume to speak on behalf of Chemero’s (2009) *radical embodied cognitive science*, which combines Gibson’s (1979) ecological psychology with advanced tools in dynamical modeling. In radical embodied cognitive science, perception is taken to be direct, in that it does not involve internal images, representations, or computational processes. Animals are in unmediated contact with

their environments. This, of course, entails a rejection of the neurocognitivist claims that Rachlin rejects; according to radical embodied cognitive science, the brain is not a computer, and cognition is not a kind of computation. Moreover, in radical embodied cognitive science, animals and their environments are understood as unified systems. The temporal unfolding of these animal–environment systems is modeled using dynamical systems theory, a branch of mathematics devoted to the description of change over time. Thus, as with wide computationalism, cognitive systems are taken to be extended in space, but they are also taken to be extended in time. This is true as a theoretical principle and methodologically. Theoretically speaking, radical embodied cognitive science understands perception not as a brain state, but as something that an animal does by actively exploring the environment, by moving eyes, head, neck, torso, and sometimes the whole body. Exploring the environment takes time. Methodologically speaking, this movement is modeled dynamically, often with time series analysis.

We can illustrate this with some of our recent experiments on extended cognition and conscious experience. We had subjects play a simple “herding” video game: Using a mouse, their task was to control an onscreen cursor to force a moving object to the center of the monitor; the second object is only semicooperative, in that it can be pushed by the cursor but also moves randomly. Subjects are allowed to practice the game until they are comfortable with it before trials begin. During trials, at a certain point while subjects are playing the game, the connection between the mouse and cursor is temporarily disrupted so that the cursor movements no longer match mouse movements; after a few seconds the mouse–cursor connection is restored. Also, during the trials, we have participants count backwards by 3 s.

In our first versions of this experiment (Dotov, Nie, & Chemero, 2010), we used a motion tracker to measure hand–mouse accelerations during the trial. We analyzed the acceleration data using detrended fluctuation analysis, a kind of time series analysis that measures correlations in variability over time. Prior research has shown that fractal structure in variability (i.e., a similarity in variability over short temporal scales and longer temporal scales) indicates that a system is *interaction dominant* (Bak, Tang, & Wiesenfeld, 1987; van Orden, Holden, & Turvey, 2003). An interaction-dominant system is a unified system, the components of which determine one another's dynamics nonlinearly so that it is impossible to separate the functional roles of any components from one another. In other words, an interaction-dominant system is nonmodular. The analysis showed that the hand–mouse acceleration variability was fractally structured while the mouse–cursor connection was good, and that this fractal structure decreased during the temporary disruption of the mouse–cursor connection. That is, when the mouse was working correctly, the participant–mouse system constituted a unified, extended, interaction-dominant system; when the mouse was not working correctly, it did not. We also found that during the mouse disruptions, the participants' counting rates decreased dramatically, almost to zero.

Recently, we have used the same experimental setup to study extended conscious experience. In these new experiments, in addition to measuring hand–mouse movements and counting rates, we also measure several physiological factors with known connections to changes in conscious experience (heart rate, respiration rate, and galvanic skin response). These new experiments confirm the findings concerning extended cognition mentioned above: While the mouse–cursor connection is

working well, the participant and mouse were a unified, interaction-dominant system, but they were not when the mouse–cursor connection was disrupted; the mouse–cursor disruption was accompanied by a decrease in counting rate. We also found that all of the physiological measures increased during the mouse disruption. This suggests that the disruption of the participant–mouse system caused a stress response (increased heart rate, respiration rate, and galvanic skin response), which is to say a change in conscious experience (Wojcik & Chemero, unpublished data). Here, conscious experiences are understood not as changes to the brain or to any internal computational processes; instead, we see them in changes in changes in behavior and bodily response to situations.

This demonstration of a cognitive, conscious system that is extended in space is utterly free of neurocognitive assumptions; we measure only behavioral changes over time. Consciousness and action are not just inseparable; they are the same thing. Notice too that this cognitive system is necessarily extended in time. We can see nothing in this research that should be objectionable to Rachlin or to any other behaviorist. We suggest that Rachlin should not paint all proponents of extended cognition with the same brush. At least some of us (the radical embodied cognitive scientists, and probably Noë) are working in a framework that a teleological behaviorist should find congenial. Moreover, we are working on issues, like consciousness, that have been difficult heretofore for behaviorists to address in the lab.

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